PLDS
Pilot Land Data System

The goal of the Pilot Land Data System is to establish a distributed, interactive, data and information system to support access to data of interest to NASA's land ists.

Supporting an Active Ecosystem Project: Status and Lessons

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The collaboration between the Pilot Land Data System (PLDS) site at the Ames Research Center and the Oregon Transect Ecosystem Research (OTTER) Project, was first introduced in this newsletter in May 1990. Since then, considerable progress has been made in supporting the data needs of the active ecosystem science project. While most of the data for the project have been collected and are available via the PLDS online inventory, more work must be accomplished before the collaboration effort is complete.

Project Participants

The OTTER Project is funded through NASA's Land Processes and Life Sciences Divisions (Codes SEL and SBR). Its principal objective is to estimate major fluxes of carbon, nitrogen and water through forest ecosystems using remotely sensed data. More than 20 scientists from over 10 research institutions are participating in testing and validating the predicted fluxes and the biological regulation of these fluxes as simulated by ecosystem processes models. Data have been collected at six sites along an elevational and climatic gradient in west central Oregon principally during the spring, summer and fall of 1990. Additional data were collected in spring 1991.

The bulk of the data are obtained from instruments flown on satellites and high-altitude, medium-level, light and ultralight aircraft. Satellite data will number over 100 scenes of Advanced Very High Resolution Radiometer (AVHRR) data including raw NOAA level-1B AVHRR data, geometrically corrected and subsetted AVHRR data, and registered composite AVHRR data from the EROS Data Center.

NASA ER-2, C-130 and DC-8 aircraft, as well as light and ultralight aircraft, participated in the acquisition of data over the Oregon transect sites and were equipped with several sensors:

- Daedalus Thematic Mapper Simulator (TMS)
- Airborne Visible Infrared Imaging Spectrometer (AVIRIS)
- Thermal Infrared Multispectral Scanner (TIMS)
- Large-format color infrared cameras (RC-10)
- Advanced Solid-state Array Spectrometer (ASAS)
- NS001 Thematic Mapper Simulator
- Airborne tracking sunphotometer
- Synthetic Aperture Radar (SAR) instrument
- Fluorescence Line Imager (FLI)
- Compact Airborne Spectrographic Imager (CASI)
- Spectron Engineering (SE) 590
- Barnes Modular Multiband Radiometer (MMR)
- Surface temperature measurements and video tapes

Spectral reflectance measurements using a variety of spectro-radiometers were also collected by OTTER investigators as ground truth for remotely sensed data. Other ground data collected include base station meteorological, field sunphotometer, and ceptometer data as well as various biochemistry, biophysical, physiological and nutrient cycling measurements.

The data for the entire project, when they are all received, are expected to total over 13 gigabytes. Results from several simulation runs of a forest ecology model will be retained for future analyses, and data derived from mathematical calculations on raw data and from combinations of bands of raw data, such as leaf area index, are also being generated.

The Data System

The PLDS is a data and information system serving NASA-supported investigators in the land science community. The three sites of PLDS, one each at the Ames Research Center

(ARC), the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL), operate computer hardware and software (accessible via network and modem) that provide information about and access to data.

The PLDS site at ARC has been managing aircraft-based data for the past two years, offering information generated by the ARC High and Medium Altitude Aircraft Programs. Procedures for storing and accessing information for NS001 TMS, TIMS, Daedalus TMS, airborne sunphotometer and aerial photography have been prepared as part of the general PLDS requirements for the PLDS/ARC site.

In addition to the general requirements, the ARC site is supporting the data requirements of the OTTER Project with a computer system that has nearly 3 gigabytes of main storage and is accessible via the Internet and NSI/DECnet, as well as by 9600 and 2400 baud modem. PLDS software and procedures, developed for general PLDS data management services, are being applied to the OTTER/PLDS Collaboration. These include Transportable Application Executive (TAE) menus and procedures, the GenSQL database query software and the procedures to order data (obtained from the GSFC site).

Collaboration Goals

The OTTER/PLDS Collaboration was created and funded to simultaneously accomplish two goals: 1) to manage and distribute an extensive set of data for use by project scientists and their collaborators; 2) to support the data requirements of an active science project.

ARC-Provided Services

In order to support the data needs of the OTTER Project, several services have been identified to be provided by ARC. They are:

1) PLDS/ARC will work closely with OTTER Project scientists from NASA centers and universities to place the data (and information about the data) into the PLDS inventory on the ARC computer and database system.

2) OTTER scientists will have access to the data and information via PLDS-developed software and procedures that allow database query and data ordering.

3) For all image data that are stored offline on magnetic tape, the PLDS staff at ARC will provide timely tape duplication and distribution services. A file transfer capability exists on PLDS for the retrieval of datasets stored online in files for the following OTTER data types: airborne sunphotometer, field sunphotometer, airborne and field Barnes MMR spectrometer, airborne and field Spectron SE393 and SE590 spectrometers, other field spectrometers and Forest-BGC model data.

4) Where assistance in the development of formats for investigator-collected data (such as ground-based spectrometer data) is required, PLDS will provide coordination and format documentation services.

5) The ARC site will provide a network file-transfer capability to coincident meteorological and canopy chemistry data that are archived online at the Forest Science Data Bank at Oregon State University.

Support Activities

The PLDS/ARC site has performed several specific activities during the two years of the OTTER Project to provide the services delineated above. The data dictionary (for the data types to be handled in the project) was implemented according to the schedule for expected data receipt. Data entry procedures for the entry of information for data types (online and offline) were created and tested. Menus for use by investigators to access information about OTTER data were developed and placed in the PLDS TAE structure.

As data have been received from data collection facilities, data and information have been entered into the PLDS/ARC inventory and validated. A network connection to the Forest Science Data Bank at Oregon State University was established using the TCP/IP file transfer protocol within a TAE procedure, allowing scientists to retrieve the data. At OTTER team meetings, data file formats for the wide variety of data types, more precise schedules for dates of data collection, the volume of data to be collected, and expected data needs of individual scientists were determined. Sufficient media and shipping materials for the expected volume of data to be distributed were procured. Procedures for tracking data orders and the receipt of data by scientists were implemented.

More services than were envisioned at the Project's outset have been provided. A special

addendum to the *PLDS User's Guide* dedicated to the data query, ordering and transfer needs of the Project has been completed, distributed and adjusted to reflect an upgrade to the PLDS software. Procedures for entering information into the PLDS inventory for remaining data types have been created. Software to automatically enter information about certain types of data, such as ASAS data, was written. A new format for investigator-collected spectrometer data was negotiated between scientists and PLDS information system staff. Documentation displaying the layout of the fields for the new format and a set of guidelines for documenting spectrometer data were written and distributed.

Status of the Data

Most of the raw data (and information about the data) from 1988 and 1989 and from the major campaigns of 1990 and 1991, have been collected and are accessible through the ARC online inventory. PLDS entries exist for the following types of raw data: aerial photography, airborne sunphotometer, ASAS, AVIRIS, Daedalus TMS, TIMS, and NS001 TMS. Data have been processed for the field sunphotometer and the Spectron SE590 spectrometer. In addition, simulation runs of the Forest-BGC model have been performed by investigators at the University of Montana, and information about the runs has been placed in the PLDS database. AVHRR data tapes are expected soon from the processing facility and airborne SAR data should be fully processed within the next few months.

Future Support

The ARC site will continue to support the OTTER Project with data entry, data distribution and assistance in the use of PLDS to determine data availability and to order data. Data types such as AVHRR and SAR, as well as spectrometer data, will be entered into the PLDS inventory. Information about and access to additional simulation runs of the Forest-BGC model will also be made available.

In addition to the OTTER datasets already managed by ARC, derived data will be inventoried. As Project investigators determine which variables are important in understanding the fluxes occurring across the Oregon Transect, ARC will become involved in characterizing the datasets for inclusion in the PLDS inventory. Attributes will be determined and procedures developed to enter the data into PLDS. Unless the volume of data is large, the data will be stored online and accessible across the network via the PLDS file-transfer function.

To preserve the large volume of OTTER data collected, ARC will publish the datasets on CD-ROMs. With assistance and guidance from investigators, the ARC staff will coordinate the processing and documentation of the data in preparation for the premastering and mastering of the CD-ROM.

Flexibility and Responsiveness

A variety of factors change throughout the life of an active science project. Some changes are imposed from outside the project and others are the result of reconsidering project priorities. Regardless of the source, data systems must remain flexible to these changes and respond quickly and effectively. When it was clear that one aircraft-based sensor was not going to be ready to collect data during the main data collection campaign in the summer of 1990, investigators obtained a substitute instrument. PLDS immediately offered to handle the data for the new instrument. When it was learned that some scientists had 8mm magnetic tape drives and preferred to receive large ASAS images on that medium, PLDS arranged to use an 8mm drive near the ARC facility for data distribution.

At the beginning of the OTTER Project, for example, the prospect of archiving and making Forest-BGC model files available to investigators was not discussed. At a team meeting, the placement of the various input, results and documentation files from the forest ecosystem model (in a central archive with queryable information about simulation runs) was advocated and approved. PLDS responded immediately by placing the model files online.

Providing Information

Communication between the project scientists and the information system is also critical. A good example of the level of communication that is necessary can be drawn from collecting, processing and validating field data. Scientists in active science projects like OTTER need to know what field data have been collected by their colleagues, and the condition of and methods used to collect those data.

The Ames staff worked closely with investigators to understand the various data collection techniques (that involved ultralight and light aircraft-based collections as well as ground-based collection) of each investigator gathering spectrometer data. A common format that could be used by all investigators was negotiated. The approved spectrometer data format was written and distributed to all scientists. Guidelines for documenting the spectrometer data, including information about data collection methods and possible problems with the data, were written and distributed. Data and documentation that have been received from investigators were examined by ARC staff for compliance with the approved format, for general quality, and for completeness of the documentation. PLDS is currently working with investigators to ensure that criteria for evaluating the spectral data and documentation from the various data collectors are generated and then applied in the evaluation.

Lessons Learned

Several important lessons have been learned from the PLDS support of the OTTER Project that have implications for all large information systems. Undoubtedly, more lessons will be learned throughout the remainder of the project, and these will be shared in a future article in this newsletter. But perhaps the most important message is that large information systems need to be flexible, responsive and communicative with project participants and organized to focus on the needs of the project. If the lessons that were learned from the PLDS support of OTTER can be applied in the upcoming Earth Observing System era, then science projects will be able to create and preserve useful and unique datasets both for project investigators and for subsequent research by other members of the land science community.

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International Space Year

Conference on Earth and Space Science Information Systems

As part of the 1992 International Space Year (ISY), an international conference devoted solely to Earth and space science information systems will be conducted at the Pasadena Convention Center, Pasadena, Calif., February 10-13, 1992.

This conference will promote and enhance international scientific communication and cooperation for the collection, processing, archiving, distribution and analysis of Earth and space science data. This goal will be accomplished by discussion among researchers and information systems developers from the international space science community. The role of information systems in international cooperation, education and outreach are topics of special interest.

Papers on the following topics will be presented:

- Earth and space science information system needs and trends
- Science information system morphologies and architectures
- Data management policies
- User interfaces
- Seamless and transparent global access to data and computer resources
- High-performance computing and communications
- Application and demonstration of new technologies
- Outreach opportunities for education

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